5-9-2005

Freezing crops and freezing soil

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The first four days of May 2005 brought freezing temperatures to the northern Corn Belt. Warmer-than-usual April temperatures had prompted considerable "early" crop planting. The freeze was damaging to emerged corn and in a few cases to planted but not emerged corn and soybean. Damage to crops is not always immediately apparent. Frozen leaves become quickly obvious, but viability of the plant, and the potential for recovery with a minimal impact on ultimate yield, is often not evident for several days.

Overnight temperatures at major reporting stations were typically 23° F or below for locations north of Interstate 80 in Iowa. Localized reports of 18° F were common. Several farmers called Iowa State University Extension reporting that soils were frozen to a depth of 1 to 2 inches. The common question was, "did it kill the plants that were germinating but not yet emerged, and did it kill the growing point of the corn that had already emerged?"

The general rule is: corn plants may survive frost that kills the visible leaves because the growing point is below the soil surface until after the V3 stage. This is a valid concept and the recovery of the corn depends on the growing point surviving, the plant remaining free of disease that could invade following the freeze damage, and the success of the growing tissue emerging. The soil temperature at the 1-inch depth may (but not necessarily) be a little warmer than the temperature of the air near the ground. However, if the soil was clearly frozen to the depth of an inch or more (that is, below the growing point) can the plant survive? Simply, "Yes, it can." This is another "wait a day or two and see" situation. The reason the plant may have survived in the frozen soil is almost a technicality; the plant dies when the temperature of the plant falls below 28° F and the frozen soil may not be that cold.

If the soil is dry, it is likely to be as cold as the temperature just above the soil. But if the soil is moist, the water will freeze when the temperature falls to about 32° F. As water freezes some heat is released, sufficient heat to keep the temperature from falling below 32° F as long as there is still some water transforming to ice. It is not uncommon to have the soil temperature fall rapidly to 32° F and then hold at 32° F for two or more days (nights) of air temperatures below 20° F. This was observed at our agricultural weather stations during the springs of 1999, 2000, 2001, 2002, and this year. As long as the soil temperature at the depth of the growing point did not fall to 28° F or lower, the plant has a chance of survival.

Some differences are likely to be seen with the tillage practice used. In several northern Iowa studies the soil temperature at the 2-inch depth in no-till was 1-2° F warmer than in conventional tillage fields. The residue cover contributes to slowing heat loss from the soil, and it contributes to higher moisture content as well. Both factors can positively influence the likelihood of plants surviving freezing temperatures.